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ABSTRACT

Members of the National Association for Research in Science Teaching (NARST) were asked to list specific priorities for research in science education. A total of 101 members, approximately 13% of the NARST membership, responded with a total of 398 statements placed into one of six general research categories: (1) Teacher Education; (2) Science Curriculum; (3) The Learner; (4) Classroom Variables; (5) The Teacher; and (6) Research Methodology and Focus. In addition, responses were placed into distinct classes within each general category. The following list of 12 research suggestions (in order of priority) represents a framework from which research possibilities for dissertations and proposals could be drawn: (1) Learning Strategies; (2) Learning and Development Not Related to Piaget Model; (3) Student Attitudes and Values Concerning Science; (4) Learning and Development According to Piagetian Model; (5) Identification of Content (Concepts and Processes); (6) Goals of Science Education; (7) Placement and Sequence of Content; (8) Content of Teacher Education Programs in Science and Education; (9) Unified or Integrated Curriculum; (10) Students' Inherent and Cultural Characteristics; (11) Implementation of Research; and (12) Instructional Materials and Technology. (Author/DS)

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Priorities for Research in Science Education: A Survey

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One of the major responsibilities of any profession is to identify its research needs. Such research identification enables the practitioners of the profession to not only direct their own efforts but to be informed of the research priorities of their colleagues. The practitioners of science education have, since 1975, made two overt statements of research priorities and one statement of problems facing science education as well as a statement of hypothesized solutions to those problems.

EARLIER WORK

In 1975 a six-member committee was appointed by the NARST to address the research needs in science education. Each committee member produced a position paper which was shared with the entire committee. The content of the final report was compiled from those position papers and a two-day dialogue among the committee members and two officers of the NARST and was published in this journal (Yager, 1978). Eight areas of needed research in science education were identified.

The NARST commissioned a second study aimed at identifying research priorities in science education. That study used the Delphi technique and solicited responses from the NARST members in the United States and Canada (N=780). Initially U.S. and Canadian members on the mailing list of NARST

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were requested to nominate three "needed areas of research in science education." The respondents were not asked to rank those three areas. The researchers then condensed 729 nominations into thirty-five statements representing the highest priority areas of research identified. Those statements were then returned to the 780 NARST members who rated the statements in a one to ten priority scale with one representing the highest priority (Butts, et al., 1978). That feedback procedure, characteristic of the Delphi statistical technique, reduced the variance in the responses by allowing the respondents to make successive judgments about the priorities for science education. The initial phase of the study solicited free responses from the respondents. The members of the NARST were next asked to rank the thirty-five statements that had been formulated by the researchers from the initial data in order of priority. Thus, the priority system was not established on free responses, but on condensations of these free responses by the researchers.

In 1978, a group headed by Yager contacted the science education personnel at the 28 institutions which produce 95 per cent of the doctorates in science education in the United States and first asked them to list what they perceived as the major problems in science education (Gallagher and Yager). The science educators were next asked to supply what they believed to be the solutions to those problems (Renner and Yager). The reports resulting from those efforts did not specifically list research problems but, as might be imagined, the results contained a great many ideas having research potential.

Each of the completed works designed to identify the needed research in science education used a unique procedure for securing the data and/or presenting its findings. The committee report represented decisions arrived at by considering detailed input from the elected and recognized leadership within the NARST. The Delphi study began by soliciting free responses from the entire membership of the NARST. Those data were then reduced to 35 statements which the membership was then asked to rank in order of priority. Even though the research-identification potential from the Yager group is high that group had the identification of needed research areas in science education only as a tangential goal.

The practitioners of any area are, no doubt, the best qualified to identify the needed research in that area. Each of the foregoing works represents a closer and closer approximation to the goal of letting each member of the NARST have the opportunity to have his/her opinion recorded about what research is needed in science education. This report represents another approximation to that goal.

THE PRESENT STUDY

Securing the Data

In December, 1979, each member of the NARST received a joint communication from the President, President-Elect, and Research Director of the organization asking him/her to list in order of priority what the member believed to be the five most-needed areas of research in science education. No other instruction and/or direction was given. A total of 101 members responded with a total of 398 statements. That number of respondents represents approximately 13 per cent of the membership of the NARST. While that percentage is not large it can be viewed as coming from persons interested enough in research in science education to send a reply.

Data Processing Procedures

The responses from each contributor were physically cut apart and stacked according to priority. Each piece of paper was labeled with the priority rating its orginator had given it. At the end of that process five priority stacks of research suggestions had been collected. As might be imagined a great deal of diversity of research topics was present in each of the five stacks.

The second step in processing the data was to assign subject categories--for example, curriculum or teacher education--to each priority stack. At the completion of categorization process of the priority stacks six subject categories were identified. The research suggestions were then sorted into the six subject categories--each suggestion, however, retained the priority designation assigned to it by its originator.

The third step involved studying each of the subject categories and identifying the specific classes of research suggestions in each. The six subject categories and the classes of research suggestions in each follow.

The Data

1. Teacher Education. This subject category encompasses all references to teacher education including undergraduate curriculum in science and pedagogy, inservice education and graduate education.

   1.1 Content of Teacher Education Programs in Science and Education. This class contains responses which were addressed to the content of both education and sciences courses found in teacher education programs.

1.2 Teaching Procedures Used in Teacher Education Programs in Science and Education. Responses from the sample directed at the procedure used in teaching prospective teachers in science and science education make up this class.

1.3 Recruitment and Selection of Teachers. Suggestions for the research needed or the methods and factors which can affect the attraction of good, competent science education personnel comprise this class.

1.4 Characteristics of Inservice Education. Research suggestions into how inservice education and professional development programs are conducted are in this class.

1.5 Preparation of College Teachers for Teaching. This class refers to the education and professional development of college and university teachers.

2. Curriculum in Science. This subject category includes research directed at primary, secondary and college curricula in science.

2.1 Special Programs. This class consists of references to science curricula designed for non-traditional student groups including non-college bound students, mentally and physically handicapped students, remedial students and adults.

2.2 Techniques of Curriculum Development. This class includes proposals to study curriculum development methods and projects both on the local and national levels.

2.3 Identification of Content (Concepts and Processes). Proposals for research into what the content of science being taught is, what it could be, what it should be, and how it is kept current comprise this class.

2.4 Placement and Sequence of Content. This class consists of proposals for research into what science concepts should be and are in science courses as well as their sequence.

2.5 Processes and Skill Development. Suggestions for research into the acquisition of thinking processes and academic skills as part of the science curriculum make up this class.

2.6 Unified or Integrated Curriculum. This class contains suggestions for research into a unification of the science curriculum across grades K-12 and interdisciplinary approaches to the science curriculum.

2.7 The Laboratory. Research suggestions aimed at "hands on" or "laboratory-centered" science curricula make up this class.

2.8 Goals of Science Education. This class is comprised of research suggestions which are directed at goal determination in science education; numerous references to scientific literacy were found.

3. The Learner.

3.1 Students' Ideas of How the World Works. This class is formed by references to the concepts students hold when they come into a classroom and how those concepts are acquired by the learners.

3.2 Learning and Development According to the Piagetian Model. Research suggestions concerned with the Piagetian developmental model comprise this class.

3.3 Learning and Development not Related to the Piagetian Model. This class concerns research suggestions centered on the intellectual abilities students bring into the classroom, and the effect those abilities have to subsequent learning.

3.4 Students' Inherent and Cultural Characteristics. Proposals for research which analyze the effects of students' inherent characteristics (e.g., gender, race, mental ability, and handicaps) and cultural characteristics (e.g., background) on learning science are found in this class.

3.5 Student Attitude Toward and Values Concerning Science. This class contains research suggestions related to the effect student attitudes about science have on learning science and how learning science influences students' values.

3.6 Evaluation of Students. How to evaluate students and the effects of that evaluation on the students are the research suggestions which make up this class.

4. Classroom Variables. This category is made up of classes of research suggestions that relate to the process and materials of instruction and the learning environment.

4.1 Class Setting. The research suggestions found in this class are directed at the influence such physical factors as classroom size, the classroom setting and the community have on learning science.

4.2 Instructional Strategies. The effects of teaching strategies on the ability of the learner to solve problems, think critically and understand science content is contained in this class.

4.3 Instructional Materials and Technology. This class includes responses concerned with the use of technology (e.g., computers and television) in effective science teaching and the education of the public in the use of technological apparatus.

5. The Teacher. This category is formed by grouping responses discussing the teaching procedures used in science education, predictors of success in teaching science, attitudes of science teachers toward science, and factors which influence the preceding concerns.

   5.1 Teacher Characteristics. This class encompasses those research suggestions directed at the affect the person and personality of the classroom teacher have upon student learning. The research suggestions includes such teacher characteristics as the relationship between the cognitive learning style of the teacher and the cognitive learning style of the learner and how the self-image and aspirations of the teacher influence the learning of students. Thus "characteristics" are different from the next two classes, "Behavior" and "Attitude."

   5.2 Specific Teacher Behavior. This class consists of research suggestions regarding such specific teacher behavior as the language used by the teacher, the impact of interpersonal skills on student achievement interest in science, and establishing specific links between teacher-performance variables and measures of student outcomes.

   5.3 Teacher Attitudes. Research suggestions regarding the relationship between attitudes of science teacher toward science and teaching and their teaching performance form this class.

6. Research Methodology and Focus. The classes found in this category include research suggestions directed at research methods, as well as types of methods other than the traditional experimental approach.

   6.1 Historical Research. This class contains research suggestions aimed at using the history of science education to understand current issues and make predictions for future directions. The research suggestions in this class also encourage using historical research as a method for research in science education.

   6.2 Research Surveys. Research suggestions for the use of the survey to identify and resolve educational issues are contained in this class.

   6.3 Evaluation Methods. The development and use of evaluation instruments and methods are the research suggestions placed in this class.

   6.4 Research and Research Methods. Suggestions for research into the effectiveness of research techniques and procedures comprise this class.

   6.5 Implementation of Research. This class is concerned with discovering methods for the implementation of research findings in a school setting.

   6.6 Research on a Theory Basis. This class consists of suggestions encouraging focusing research on specific theoretical models; e.g., behavioral, Piagetian and Ausubelian theories.

Isolating Research Priorities

Table 1 displays the number of times each class within each research category was listed; the priority assigned to each class is also included in Table 1. A total of 398 research suggestions were made in the survey, and in Table 1, all research problems nominated are accounted for. In the space following the total number of class nominations for each category in Table 1, a percentage is found. That percentage represents the portion of the total class nominations (398) represented by each category; for example, 296 per cent of the total 398 class nominations were devoted to Category Three, "The Learner." The percentages given for each category in Table 1 allow an evaluation to be made of the research priorities of the members of the NARST who responded to the invitation to help identify needed research. The percentage found at the end of each priority column in each category, represents the percentage the accompanying number is of the total research suggestions found in the category. The categories are in order of number of suggestions, as follows:

1. Category 3: The Learner - - - - - - - - - - - - - - - 29.6%
2. Category 2: Curriculum in Science - - - - - - - - - - 23.1%
3. Category 4: Classroom Variables - - - - - - - - - - - 18.1%
4. Category 6: Research Methodology and Focus - - - - - - 13.1%
5. Category 1: Teacher Education - - - - - - - - - - - - 10.1%
6. Category 5: The Teacher - - - - - - - - - - - - - - - 6.0%

(Insert Table 1 about here)

Classes Within Categories Receiving Most Support. This section of the report isolates the first five classes of research problems within each of the six categories that received the most support from the membership in the NARST. The leading three categories in Table 2 show an interesting and revealing pattern of reserach concerns of those responding to the survey when the leading class within each category is studied. Those concerns are:

Category 3: The Learner - - Class 3.3, Learning and Development of Students.

Category 2: Curriculum - - Class 2.3, Identification of Content

Category 4: Classroom Variables - - Class 4.2, Instructional Strategies.

The inference can be made from those research concerns that science-education researchers are most interested in and concerned about student learning, the content to use in conducting that learning, and using the most effective teaching strategies possible in the classroom. The principal research concern of science education for learning is made more evident when Classes 3.3 and 3.2 are combined; that combination captures 54 per cent of the research suggestions made in the leading research category isolated in the survey. Science educators are truly concerned about student learning in science and the fact that they feel additional research is needed so badly infers that they do not believe adequate knowledge about student learning exists.

The fourth-place category - - Research Methodology and Focus - - also reveals an additional concern of science educators; they feel that we need to do research on how to implement research findings. That finding again suggests - - as do Categories 3, 2, and 4 - - the concerns of science educators to improve science teaching. Categories One and Five reflect such small numbers of research suggestions and/or have such small differences among the classes that they will not be discussed here.

Research Categories and Classes Assigned the Highest Priority

Each contributor to the data being reviewed in this report was asked to list the research areas (what have been called "research classes" here) in order of priority. A total of 101 research suggestions were given a "Priority 1" (see Table 1). Knowing the percentage of "Priority 1" responses for each category would assist in deciding the importance -- in the minds of respondents -- of that category. The percentage of support

(Insert Table 3 about here)

for each of the six isolated research categories is found in Table 3. The order of importance of the categories judged by the percentage of first priority responses is 3, 4, 2, 6, 5 and 1 and judged by the percentage of second priority responses is 3, 4, 6, 1, 2 and 5. Those orders have some deviation from the order of importance assigned to the categories when total numbers of research class nominations were considered. The percentage of responses in each class for each category will be found in Table 1.

Perhaps the research concerns for the members of the NARST responding to the survey can be better seen if the first and second priorities of each class within each category are studied. The data necessary for that study are shown in Table 4. The categories in Table 4 are listed in the order of importance revealed by the survey, and only those five classes showing the greatest percentage are included.

Perhaps the best overall view of the concerns of science educators who are members of the NARST can be obtained by examining those classes that contain the greatest total number of nominations regardless of priority (the column on the extreme right in Table 1). Suppose the criterion that in order to be considered an important concern a research suggestion had to be nominated by three per cent of the respondents -- 12 people. When that arbitrary restriction is imposed upon the data in Table 1, the following order-of-importance of research suggestions emerges (the number shown represents the number of times that class of research suggestion was suggested):

1. Instructional Strategies (57)
2. Learning and Development not Related to the Piagetian Model (41)
3. Student Attitudes toward and Values Concerning Science (33)
4. Learning and Development According to the Piaget Model (22)
5. Identification of Content (Concepts and Processes) (18)
6. Goals of Science Education (16)
7. Placement and Sequence of Content (14)
8. Content of Teacher Education Programs in Science and Education (13)
9. Unified or Integrated Curriculum (13)
10. Students Inherent and Cultural Characteristics (13)
11. Implementation of Research (13)
12. Instructional Materials and Technology (12)

The foregoing twelve research suggestions represent what those science educators interested enough in the profession's research to reply to the survey believe should be concentrated upon in our research efforts. Those twelve research suggestions could represent a framework from which research suggestions for dissertations and proposals could be drawn.

We would, we believe, be remiss if one rather prominent factor in the data were not commented upon. Beginning in the late 1950's much effort and funding has gone into producing science teaching materials which were "hands on" or laboratory based. Only eleven persons listed research suggestions related to using the laboratory in teaching (Class 2.7). That finding has two interpretations: the work during the 1960s and 1970s was so well done that no further need exists to emphasize the use of the laboratory; the profession know how and accepts it should be done. Or perhaps the understandings needed in order to use the laboratory have not been developed and the laboratory as a laboratory and not a place to verify what students have been told, is being ignored in practice and research. When the majority of current science teaching materials is examined, the inference that the second reason advanced for the neglect of the laboratory by the respondents to the survey is nearly irresistable. We hypothesize that when science education forgets and/or neglects the laboratory, science education is headed in an undesirable direction. If science is truly a quest into the natural world, the laboratory cannot be ignored.

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TABLE 1

CATEGORIES AND CLASSES OF RESEARCH PRIORITIES

Category	Class	PRIORITY 1	2	3	4	5	No Priority	No. of Times the category was listed
1. Teacher Education	1.1 Content of Teacher Education Programs in Science and Education	3	3	3	2	2		13
	1.2 Teaching Procedures Used in Teacher Education Programs in Science and Education		4	2	2			8
	1.3 Recruitment and Selection of Teachers				5			5
	1.4 Characteristics of Inservice Education	2	2	2	1	3		10
	1.5 Preparation of College Teachers for Teaching			3		1		4
	TOTALS: Category 1.	5 / 12.5%	9 / 22.5%	10 / 25.0%	10 / 25.0%	6 / 15.0%		40 (10.1%)
2. Curriculum in Science	2.1 Special Programs	2		3	3	2		10
	2.2 Techniques of Curriculum Development	1		1				2
	2.3 Identification of Content (Concepts and Processes)	5	2	1	5	3	2	18
	2.4 Placement and Sequence of Content	5	4	3	1	1		14
	2.5 Processes and Skill Development	2	3	3				8
	2.6 Unified or Integrated Curriculum	2	1	3	3	3	1	13
	2.7 The Laboratory	3	4	2	1	1		11
	2.8 Goals of Science Education	5	3	4	1	3		16
	TOTALS: Category 2.	25 / 27.2%	17 / 18.5%	20 / 21.7%	14 / 15.2%	13 / 14.1%	3 / 3.3%	92 (23.1%)
3. The Learner	3.1 Students' Ideas of How the World Works	2			1			3
	3.2 Learning and Development According to the Piagetian Model	8	4	3	3	2	2	22
	3.3 Learning and Development Not Related to the Piagetian Model	10	17	8	3	2	1	41
	3.4 Students' Inherant and Cultural Characteristics	4	3	4	2			13
	3.5 Student Attitude Toward and Values Concerning Science	9	6	6	7	4	1	33
	3.6 Evaluation of Students		3	1	2			6
	TOTALS: Category 3.	33 / 28.0%	33 / 28.0%	22 / 18.6%	18 / 15.2%	8 / 6.8%	4 / 3.4%	118 (29.6%)
4. Classroom Variables	4.1 Class Setting			1	1	1		3
	4.2 Instructional Strategies	17	14	14	8	1	3	57
	4.3 Instructional Materials and Technology	3	5	2	1		1	12
	TOTALS: Category 4.	20 / 27.8%	19 / 26.4%	17 / 23.6%	10 / 13.9%	2 / 2.8%	4 / 5.5%	72 (18.1%)
5. The Teacher	5.1 Teacher Characteristics	1	1	3		1	1	7
	5.2 Specific Teacher Behaviors	1	2	2	2	1		8
	5.3 Teacher Attitudes	2	1	3	1	2		9
	TOTALS: Category 5.	4 / 16.7%	4 / 16.7%	8 / 33.3%	3 / 12.5%	4 / 16.2%	1 / 4.1%	24 (6.0%)
6. Research Methodology and Focus	6.1 Historical Research	2	2		4	2		10
	6.2 Research Surveys	1	2			3		6
	6.3 Evaluation Methods		3	1	2	2		8
	6.4 Research on Research Methods	1	3	3	1			8
	6.5 Implementation of Research	6	2	2	2	1		13
	6.6 Research on a Theory Base	4	1	1	1			7
	TOTALS: Category 6.	14 / 26.9%	13 / 25.0%	7 / 13.5%	10 / 19.2%	8 / 15.4%		52 (13.1%)
	GRAND TOTALS	101 / 25.4%	95 / 23.9%	84 / 26.1%	65 / 16.3%	41 / 10.3%	12 / 3.0%	398 (100%)

TABLE 2

Classes of Research Problems within Categories Receiving the Most Support										
Category	Class	%	Class	%	Class	%	Class	%	Class	%
3: The Learner	3.3	35	3.5	28	3.2	19	3.4	11	3.6	5
2: Curriculum in Science	2.3	20	2.8	14	2.4	12	2.6	11	2.7	9
4: Classroom Variables	4.2	79	4.3	17	4.1	4				
6: Research Methodology and Focus	6.5	25	6.1	19	6.3 6.4	15 15	6.6	13	6.2	11
1: Teacher Education	1.1	33	1.4	25	1.2	2.0	1.3	13	1.4	10
5: The Teacher	5.3	38	5.2	33	5.1	29				

TABLE 3

Percentage of First and Second Priority Listing in Each Research Category						
Priority Ranking	Research Categories					
	1	2	3	4	5	6
First (N=101)	12.5%	27.2%	28.0%	27.8%	16.7%	26.9%
Second (N=95)	22.5%	18.5%	28.0%	26.4%	16.7%	25.0%

TABLE 4

Percentages of Class Priority 1 and 2 Responses by Category																				
Category	Priority 1										Priority 2									
	Class	%	Class	%	Class	%	Class	%	Class	%	Class	%	Class	%	Class	%	Class	%	Class	%
3: The Learner	3.3	30.3	3.5	27.2	3.2	24.2	3.4	12.1	3.1	6.1	3.3	51.5	3.5	18.2	3.2	12.1	3.4 3.6	9.1 9.1	---	--
2: Curriculum	2.3 2.4 2.8	20.0 20.0 20.0	2.7	12.0	2.1 2.5 2.6	8.0 8.0 8.0	2.2	4.0	---	--	2.4 2.7	23.5 23.5	2.5 2.8	17.6 17.6	2.3	11.8	2.6	5.9	---	--
4: Classroom Variables	4.2	85	4.3	15	---	---	---	--	---	--	4.2	73.7	4.3	26.3	---	--	---	--	---	--
6: Research Methodology and Focus	6.5	42.8	6.6	28.5	6.1	14.3	6.2 6.4	7.1 7.1	---	--	6.3 6.3	23.1 23.1	6.1 6.2 6.5	15.4 15.4 15.4	6.6	7.6	---	--	---	--
1: Teacher Education	1.1	60.0	1.4	40.0	---	--	---	--	---	--	1.2	44.4	1.1	33.3	1.4	22.2	---	--	---	--
5: The Teacher	5.3	50.0	5.1 5.2	25 25	---	--	---	--	---	--	5.3	50.0	5.1 5.2	25 25	---	--	---	--	---	--